

**To:** The Faculty of the College of Engineering

**From:** The Faculty of the Lyles School of Civil Engineering

**RE:** New Undergraduate Course, CE39500 Fundamentals of Innovation Theory and Practice; and crosslist with ENGR 30500 Fundamentals of Innovation Theory

The Faculty of the Lyles School of Civil Engineering have approved the following creation of a new course. This action is now submitted to the Engineering Faculty with a recommendation for approval.

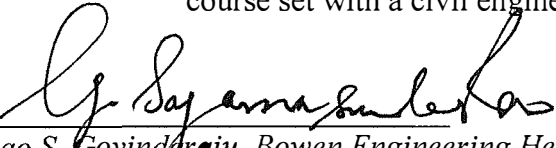
**CE39500 Fundamentals of Innovation Theory and Practice**

Sem. 1, Lecture 3, Cr. 3

Prerequisites: None

**Description:** This course is designed to provide students with initial exposure to the fundamental patterns, mindsets, behaviors, attributes, tools, and methods employed in the innovative activities of individuals and organizations. Emphasis is placed on understanding and effectively utilizing techniques to systematically drive innovation that are drawn from the fields of business, design, problem-solving, engineering, and the social sciences. Lectures, in-class small group activities, and individual and team assignments are employed across an array of contemporary socio-technical challenges to provide students with the opportunity to apply conveyed theory and methods to rigorously structure problems, understand involved stakeholders, utilize innovation motifs and analogical reasoning to develop robust views of potential solutions spaces, tailor solution design to stakeholder context, consider the full suite of functional, social, and emotional dimensions that could influence solution prioritization, and document and systematically assess underlying solution assumptions to iterate toward a viable and sustainable forward looking plan that could achieve target outcomes. This course serves as an entry course option for the College of Engineering Minor in Innovation and Transformational Change.

**Reason:** This course has been offered once as an ENGR29700, and six times as ENGR305-H01, with the following enrollment: S17 (7), S18 (17), F18 (17), F19 (24), F20 (19), F21 (26), F22 (28), which has included 23 civil engineering students. The faculty of civil engineering would like to increase awareness of the course among civil engineering students and ease its inclusion in civil engineering student plans of study by incorporating it into the civil engineering course set with a civil engineering course number.

  
Rao S. Govindraj, Bowen Engineering Head of Civil Engineering  
Lyles School of Civil Engineering

**Supporting Document to the Form 40 for a New Undergraduate Course**

**To:** Faculty of the College of Engineering

**From:** Faculty Member: Joseph Sinfield  
Department: Lyles School of Civil Engineering  
Campus: West Lafayette

**Date:** September 29, 2022

**Subject:** Proposal for New Undergraduate Course Required to Accompany Registrar's Form 40

**Contact for information if questions arise:** Name: Joseph Sinfield  
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**Course Subject Abbreviation and Number:** CE39500

**Course Title:** Fundamentals of Innovation Theory and Practice

**A. Justification for the Course**

This course has been offered once as an ENGR29700, and six times as ENGR305-H01, with the following enrollment: S17 (7), S18 (17), F18 (17), F19 (24), F20 (19), F21 (26), F22 (28), which has included 23 civil engineering students. The faculty of civil engineering would like to increase awareness of the course among civil engineering students and ease its inclusion in civil engineering student plans of study by incorporating it into the civil engineering course set with a civil engineering course number.

**B. Learning Outcomes and Method of Assessment**

*Learning Outcomes* – Upon successful completion of this course, students will be able to:

1. Develop working knowledge of established innovation forms and motifs
2. Demonstrate ability to link innovation motifs to specific classes of problems
3. Understand, and be able to pursue, the core aspects of an end-to-end innovation process
4. Recognize the mental models, mindsets and behaviors of innovators
5. Gain awareness of the approaches various forms of organizations take to systematically innovate
6. Acquire leadership and communication skills through teamwork, oral presentations, and written deliverables

*Method of Assessment* – These learning outcomes are assessed as follows

Weight	Activity
45%	Team Working Exercises: Students in the class divide into teams of 3 to 5 to apply specific innovation concepts, such as issues analysis, ecosystem definition, empathy

	driven stakeholder profiling, analogical solution development, and assumption analysis to a variety of contemporary real-world challenges in weekly working exercises. Team composition and problem focus is varied throughout the semester. A portion of team grades will be linked to peer evaluation.
30%	Homework: Brief individual written assignments are employed to guide students through exploration of course concepts.
15%	Quizzes and/or Cases: In-class quizzes and/or take-home case exercises are used to demonstrate student understanding of discussed innovation principles.
10%	Individual engagement in team activities and group discussions, as well as analysis/working exercise leadership. (Instructor and peer evaluation)

*Method of Instruction – Lectures, Case Discussions, and In-class Team Working Exercises*  
Course content is presented through lectures and case discussions, and reinforced through individual and team assignments as well as in-class joint problem solving sessions. Concepts are explored by students as individuals through case analysis and/or homework assignments and/or examined in class in case discussions, and then employed by student teams in the context of specific challenges. Report-outs by teams then foster deeper discussion of the core concepts and engage students in participatory design and peer-to-peer feedback.

**C. Prerequisite(s)**

None

**D. Course Instructors**

Name	Rank	School	Graduate Faculty
Joe Sinfield	Professor	Civil Engineering	Yes

**E. Course Outline**

Week	Topic	Reading/References
1	I. Achieving leadership through innovation	
2, 3	II. Innovation motifs – linking design approaches to context	Solis and Sinfield, 2018
4	III. Design and the novice to expert continuum; beyond design thinking	Crismond and Adams, 2012; Brown and Wyatt, 2010
4, 5	IV. The high-impact enabling innovation model	Sinfield and Solis, 2016a; Sinfield and Solis, 2016b; Solis and Sinfield, 2014
5, 6	V. Framing a problem: Issue analysis and hypothesis-driven problem solving	Minto, 1996; Sinfield et al., 2020
6, 7	VI. Systems thinking in socio-technical contexts	DeLaurentis and Callaway, 2004; Mostafavi et al., 2011; Gorod, et al., 2008

7, 8	VII. Ecosystem and stakeholder exploration	Belone et al., 2016; Anthony et al., 2007; Beebe, 2014
9, 10	VIII. End-user understanding	Anthony et al. 2008 (Ch. 4)
11, 12	IX. Analogical reasoning and systematic methods of solution space development	Gick and Holyoak, 1980
13	X. Engagement / involvement strategy	
13, 14	XI. Solution economics	Weill et al. 2004; Sinfield et al. 2012; Giddings et al., 2002; Liu et al., 2020
14, 15	XII. Planning to learn	McGrath and MacMillan 1995
15	XIII. Persuasive communications, public speaking, and managing Q&A	Bacon, 1996
16	XIV. Innovator attributes and best practices	Sinfield and Anthony, 2006; Sinfield et al., 2014; Girotra et al., 2010; Solis and Sinfield, 2016; Solis and Sinfield, 2018

#### F. Reading List

1. Anthony, S. D., and Sinfield, J.V. (2007) "Product for Hire: Master the Innovation Lifecycle with a Jobs-to-be-Done Perspective of Markets," *Marketing Management*, March/April, 19-24.
2. Anthony, S.D., Johnson, M.W., Sinfield, J.V., Altman, E.J., **The Innovator's Guide to Growth—Putting Disruptive Innovation to Work**, Harvard Business Press, 2008, 299 p.
3. Bacon, Terry R., "Interpersonal and Interactive Skills", Lore Innovation Institute, McKinsey & Company, 1996.
4. Beebe, J. (2014). **Rapid Qualitative Inquiry: A Field Guide to Team-Based Assessment**, Second Edition. Lanham MD: Rowman & Littlefield. 258 pp.
5. Belone, L., Lucero, J.E., Duran, B., Tafoya, G., Baker, E.A., Chan, D., Chang, C. Greene-Moton, E., Kelley, M. A., and Wallerstein, N., (2016). "Community-Based Participatory Research Conceptual Model: Community Partner Consultation and Face Validity," *Qualitative Health Research*, 26(1): 117-135.
6. Brown, T., and Wyatt, J. (2010), "Design Thinking for Social Innovation," *Development Outreach*, (12)1, 29-43.
7. Crismond, D. P., and Adams, R. S. (2012). "The Informed Design Teaching and Learning Matrix." *Journal of Engineering Education*, 101(4), 738-797.
8. DeLaurentis, D., & Callaway, R. (2004). "A systems-of-systems perspective for public policy decisions." *Review of Policy Research*, 21(6), 9.
9. Gick, M.L. and Holyoak, K. J. (1980) "Analogical Problem Solving," *Cognitive Psychology*, (12), 3, 306-355.

10. Giddings, B., Hopwood, B., and O'Brien, G. (2002). "Environment, economy, and society: Fitting them together into sustainable development," *Sustainable Development*, (10). 2, 187-196
11. Girotra, K., Terwiesch, C., and Ulrich, K. T., (2010) "Idea Generation and the Quality of the Best Idea", *Management Science*, Vol. 56, No. 4 (April 2010), pp. 591-605.
12. Gorod, A., Sauser, B., and Boardman, J. (2008) "System-of-Systems Engineering Management: A Review of Modern History and a Path Forward," *IEEE Systems Journal*, (2) 4, 484-499.
13. Liu, J., Tong, T., and Sinfield, J.V., "Toward a Resilient Complex Adaptive System View of Business Models," *Long Range Planning*, August 2020, 102030.
14. McGrath, R., and MacMillan, I. (1995). "Discovery-driven planning." *Harvard Business Review*, 73(4), 44-54.
15. Minto, B. (1996) **The Minto Pyramid Principle: Logic in Writing, Thinking, and Problem Solving**, Minto International, Inc., London.
16. Mostafavi, M., Abraham, D., DeLaurentis, D., and Sinfield, J. (2011). "Exploring the Dimensions of Systems of Innovation Analysis: A System of Systems Framework." *IEEE Systems Journal*, 5(2), 256 - 265.
17. Sinfield, J. and Anthony, S. (2006) "Constraining Innovation: How Developing and Continually Refining Your Organization's Goals and Bounds Can Help Guide Growth", *Strategy & Innovation*, November – December, v. 4, n. 6, 1, 6-9.
18. Sinfield, J.V., and Solis, F., (2016a) "Finding a Lower-risk Path to High-impact Innovations," *Sloan Management Review*, 79-89, Summer.
19. Sinfield, J.V., and Solis, F., (2016b) "Thinking Big to Address Major Challenges: Design and Problem-Solving Patterns for High-Impact Innovation, National Academy of Engineering, *The Bridge*, 11-18, Summer.
20. Sinfield, J.V., Calder, E.S., Colson, S., McConnell, B., (2012) "How to Identify New Business Models," *Sloan Management Review*, v. 53, n. 2, Winter.
21. Sinfield, J.V., Gustafson, T., and Hindo, B. (2014) "The Discipline of Creativity," *Sloan Management Review*, 55(2), 24-26, Winter.
22. Sinfield, J.V., Sheth, A., and Kotian, R. R. (2020) "Framing the Intractable – Comprehensive Success Factor Analysis for Grand Challenges," *Sustainable Futures*, August, 2:100037.
23. Solis, F. and Sinfield, J.V. (2014) "Rethinking Innovation: Characterizing Dimensions of Impact," ASEE Annual Conference, 360 Degrees of Engineering Education, June 15 - 18, 2014 Indianapolis, Indiana, Paper ID #9284.
24. Solis, F. and Sinfield, J.V. (2018), "Designing for Big X: Characterizing Design for Major Challenges," *International Journal of Engineering Education*, 34, 2(B), 1-22.
25. Solis, F., and Sinfield, J.V., (2016) "From Entrepreneur to Designer: The Transferable Design Principles of the Entrepreneur," (2016) ASEE Annual Conference & Exposition, Jazzed about Engineering Education, June 26-29, 2016, New Orleans, LA, Paper ID#15965.
26. Weill, P., Malone, T. W., D'Urso V.T., Herman, G. and Woerner S. (2004) "Do Some Business Models Perform Better Than Others?" MIT Sloan School of Management Working Paper/ MIT Center for Coordination Science Working Paper No. 226, 6 May.

**G. Library Resources**

Readings and resources for this course are readily accessed by students through the Purdue University Libraries.